Air Program National Accomplishments and Successes

2010

"Consider the importance of the atmosphere, and its quality, to the health and vitality of National Forests and the resources we manage. The atmosphere interfaces directly with every resource we manage, terrestrial, aquatic, cultural, and even our visitors, who tell us their number one reason for visiting national forests is to breathe fresh, clean air and experience our vistas and spectacular scenery."
Rich Fisher, National Air Program Manager Emeritus, 2006

State of Our National Forest Air

Air Resources Management Program

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INTRODUCTION

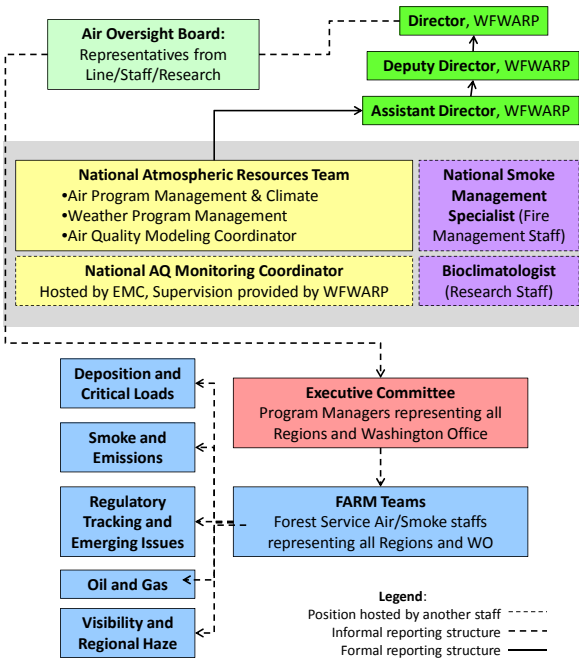
A National Overview

The Air Resources Management Program (ARM) envisions a healthy environment for current and future generations where natural processes occur. The Program believes that the health of humans and ecosystems are inseparable, clean air is essential, and science is a foundation for taking action. We focus our efforts in three main areas:

1. **Understand**: science based understanding of cause and effect
2. **Assess**: quantifying cause and effect
3. **Advise**: articulating implications of cause and effect

The Air Resource Management Program is fluent in the language and concept of air emission inventories from natural and industrial sources. The Program has longstanding working relationships with federal, state, and local air quality regulators and policy makers. We have an exemplary relationship with Forest Service Research stations and atmospheric scientists outside the agency. We are known for our ability to interpret research findings in a way meaningful for policy, regulatory input, and forest management strategies.

The Air Resource Management "Organization"


Air Oversight Board: Representatives from Line/Staff/Research
Director, WFWARP
Deputy Director, WFWARP
Assistant Director, WFWARP
National Atmospheric Resources Team
•Air Program Management & Climate
•Weather Program Management
•Air Quality Modeling Coordinator
National Smoke Management Specialist (Fire Management Staff)
National AQ Monitoring Coordinator
Hosted by EMC, Supervision provided by WFWARP
Bioclimatologist (Research Staff)
Deposition and Critical Loads
Smoke and Emissions
Regulatory Tracking and Emerging Issues
Oil and Gas
Visibility and Regional Haze
Executive Committee
Program Managers representing all Regions and Washington Office
FARM Teams
Forest Service Air/Smoke staffs representing all Regions and WO
Legend:
Position hosted by another staff
Informal reporting structure
Formal reporting structure

The purpose of the ARM Program National Report is to summarize and highlight the accomplishments of the Program.

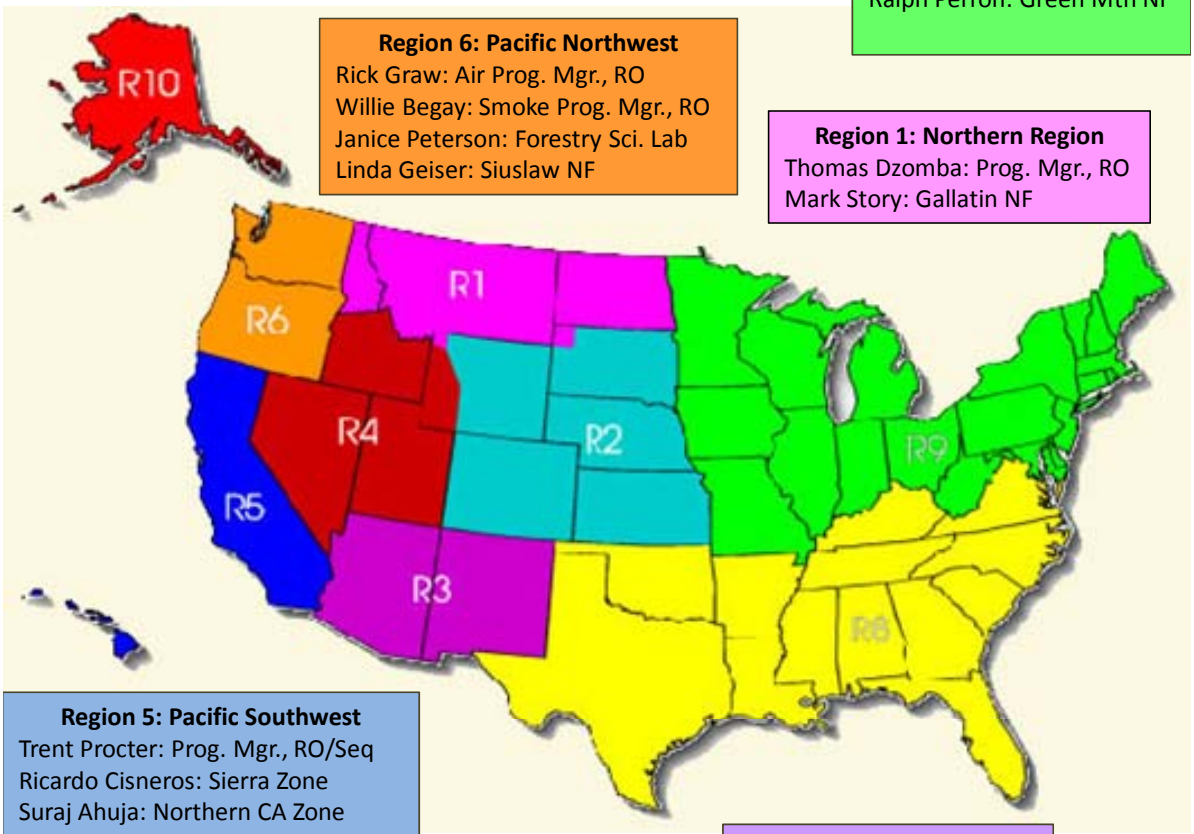
Washington Office
Anne Zimmermann: WFWARP Director
Chris Iverson: WFWARP Asst Director
Ann Acheson: Natl Air Program Manager
Bret Anderson: Modeler, Ft. Collins, CO
Ann Mebane: Monitor. Coord., Cody, WY
Scott Copeland: CIRA

Region 10: Alaska
John Lane: Prog. Mgr, RO
Karen Dillman: Tongass NF

Region 9: Northeast
Chuck Sams: Prog. Mgr, RO8
Tedd Huffman: Monon. NF
Trent Wickman: Superior NF
Ralph Perron: Green Mtn NF

Region 6: Pacific Northwest
Rick Graw: Air Prog. Mgr., RO
Willie Begay: Smoke Prog. Mgr., RO
Janice Peterson: Forestry Sci. Lab
Linda Geiser: Siuslaw NF

Region 1: Northern Region
Thomas Dzomba: Prog. Mgr., RO
Mark Story: Gallatin NF



Region 5: Pacific Southwest
Trent Procter: Prog. Mgr., RO/Seq
Ricardo Cisneros: Sierra Zone
Suraj Ahuja: Northern CA Zone
Mike McCorison: Southern CA Zone
Andrea Nick: Southern CA Zone
Don Schweizer: Monitoring Spec.
Sharon Grant: Monitoring Specialist

Region 3: Southwest
Jack Triepke: Prog. Mgr., RO
Susanna Ehlers: RO
Ron Sherron: NF's of AZ
Josh Hall: NF's of NM

Region 2 & 4: Rocky Mtn & Intermountain
Jeff Sorkin: Prog. Mgr., RO
Debbie Miller: RO
Terry Svalberg: Bridger-Teton NF
Ted Porwoll: Bridger-Teton NF
Andrea Holland Sears: White River NF
Kelly Palmer: San Juan NF
Jill Grenon: Student Career Employment Program

Region 8: Southeast
Chuck Sams: Prog. Mgr., RO
Cindy Huber: GW-Jeff NF
Judy Logan: Quachita NF
Bill Jackson: NF's of NC
Melanie Pitrolo: NF's of NC
Anthony Mathews: NF's of FL
Dan Stratton: NF's of FL

Washington Office and Regional staff working in the Air Resource Management "organization" (in 2010)

2010 National Accomplishments

To Understand, To Assess, To Advise

Data Collection and Maintenance of IMPROVE sites: Interagency Monitoring of Protected Visual Environments (IMPROVE) is the national visibility monitoring network used to track progress towards the national goal of no man made impairment in Class I areas by 2064. A perennial success story, operation of the IMPROVE network requires substantial and continuous contributions from many Air Program and Forest staff. In 2009, Forest Service site operators made about 2700 site visits to the 54 IMPROVE sites. Out of the 6300 samples collected, 5751 samples were valid (91%). Also, 47 of 51 possible sites collected enough valid samples to meet EPA's Data Completeness Criteria. All four instances where a site did not meet the completeness criteria were the result of sampler problems not related to operator performance. The effort for 2010 was very similar.

DID YOU KNOW?

In 2009 Forest Service site operators made about 2700 site visits to the 54 IMPROVE sites. **5751 valid samples** were collected out of approximately 6300 possible (**91%**).

National Environmental Policy Act (NEPA): Air quality is an important component of NEPA analysis. Failure to adequately consider air quality may jeopardize the NEPA analysis process. Compliance with Clean Air Act requirements such as conformity[1] can be demonstrated through NEPA documentation.

In 2010, the Air Program staff provided input to a wide variety of NEPA assessments. Projects involving significant air analyses include: Oil & Gas proposals, Travel Management Plans[2], R3 Copper Mine, Forest Plan revisions, Proposed Planning Rule[3], prescribed burning projects, and Power Transmission Line Extensions.[4]

Critical Loads: Critical loads are pollution exposure and deposition levels below which significant harmful ecological effects do not occur. By using more than 30 years of data, the Air Program staff and research partners have made considerable progress in developing and publishing critical load values for nitrogen enrichment and acidification. Some key accomplishments related to critical loads include:

- Collaboration with Forest Service Research to assemble empirical

[1] Conformity: an element of the Clean Air Act that requires federal actions in non-attainment areas to comply with state and local requirements.

[2] Air staff provided templates and guidance across the country

[3] Air quality is specifically mentioned in the proposed planning rule.

[4] Power Transmission Line Extensions were for renewable power in Southern California.

nitrogen critical load levels for terrestrial ecosystems across the US.

- Integration of critical load work between FS Research and the Air Program with EPA's modeled nitrogen deposition information. This led to a more accurate interpretation of air quality impacts to terrestrial resources for the Watershed Condition Assessment.
- Completion of a multi-agency critical load project for Virginia and West Virginia using an innovative approach to extrapolate critical load exceedence across the landscapes of the Monongahela National Forest (NF), George Washington and Jefferson NFs and Shenandoah National Park.
- Contribution of water chemistry data from the NRM Air database to the work of the Critical Loads Science Committee of the National Atmospheric Deposition Program.
- Using Sierra Nevada Lakes Water Chemistry Survey data to draft critical loads for alpine lakes in the Sierra Nevada.

Regional Haze: The Regional Haze Rule[1], promulgated by the Environmental Protection Agency (EPA), is designed to reduce man made impairment to visibility in Class I areas. The Air Program staff received and commented on 15 State Implementation Plans (SIPs) in 2010. If implemented, 500,000 tons of SO_2 and NO_x pollution would be reduced every year by 2018.

Additionally, the Air Quality Modeling staff from the Forest Service travelled to EPA Region 6 to train EPA modelers on the use of the CALPUFF modeling system. This was for the federal Best Available Retrofit determination for the San Juan Generating Station, which is anticipated to result in additional thousands of tons of reduction of NO_x.

The Forest Service involvement in the Regional Haze Process will result in improved Class I wilderness visibility.

Watershed Condition Assessment: The Air Program Deposition Farm Team integrated air quality and critical load concepts into the process for watershed condition assessment. As a result, all National Forest submittals included air quality data in soil contamination, water quality, and vegetation rankings. Accomplishments include:

- Developed methodology for the air quality related attributes including Forest Health Indicator-Ozone Damage attribute, Soil Condition Indicator-Soil Contamination attribute, and Water Quality Indicator attribute.
- Provided national interpretations of air quality impacts at the 6th level HUC watersheds for the Watershed

[1] The Regional Haze Rule is intended to return Class I areas to natural and/or pre industrial visibility conditions.

Condition Assessment. This included GIS coverage, tabular ratings by watershed and process documentation. Regions with more local available data were able to refine their assessments with the same procedures.

Surface Water Assessment: Surface water chemistry provides information about sensitivity and risk of increasing acidity from atmospheric deposition. The Air Program conducted laboratory analysis on over 500 surface water samples to help us assess impacts. Accomplishments include:

- Produced the National Protocol for Surface Water Chemistry Monitoring of Air Pollution Sensitive Waters. This includes training videos for stream and lake sampling protocols, field and lab quality assurance, data analysis, aquatic biota monitoring and uniform data collection forms.
- Conducted analysis of high elevation lake water chemistry data in Region 5 (Sierra Nevada) to create condition ratings for water quality attribute of water quality indicator.
- Integrated assessments of historic air quality and resource monitoring data to describe the effects of air pollution in Regions 1, 4, and 6.
- Performed wilderness water chemistry monitoring in support of the Wilderness Stewardship Program in Region 8. Implemented the 2009 Air Quality Values Plans with the 2010 initial monitoring effort.

Other Achievements

New Source Review (NSR) and Prevention of Significant Deterioration (PSD) Permit Review: The NSR/PSD permit review process protects Air Quality Related Values[6] (AQRV) on Forest Service lands by minimizing pollution from new sources or sources with major modifications. This year the Air Program provided extensive review on approximately 42 NSR/PSD permits.

Ozone and Smoke Monitoring and Evaluation: Regions installed ozone monitors in critical areas experiencing rapid and massive increases in ozone exposures due to gas field expansion. Regions also monitored the effects of smoke from fire for resource management.

Visibility Webcams: The Program leveraged our visibility webcam network to support the National Phenology Network for monitoring the effects of climate change on forest vegetation.

Wilderness Stewardship Challenge Support: Regions coordinated in developing consistent approaches for Wilderness Air Quality Value[7] plans. ARM specialists in Region 8 mentored the Region 3 Air Specialist in developing Air Quality Values plans.

[6] Air Quality Related Values are defined by regulatory language for Class I wilderness areas. http://www.nature.nps.gov/air/permits/aris/aqrv.cfm

[7] Unlike the term AQRVs, Air Quality Values are not part of regulatory language. The term applies to areas other than Class I Wilderness Areas.

REGIONAL SUCCESS STORIES

Region 1 Success Stories

Wilderness Air Quality Stewardship

The Region 1 Air Program has been monitoring air quality since 1989. Initially, monitoring plans were developed for the seven regional Class I Wilderness Areas. With the implementation of the Ten Year Wilderness Stewardship Challenge, air quality monitoring plans were developed for the remaining six regional Wilderness Areas. Today, air quality monitoring assessments are performed for all 13 regionally-managed Wilderness Areas.

Monitoring

The Region 1 Air Program currently oversees six different types of air quality monitoring throughout the Region, collecting over 300 samples each year:

Lake Monitoring Region 1 has sampled over 350 regional lakes to determine those potentially most sensitive to the effects of acid deposition. Currently, six of the most sensitive lakes are sampled annually.

Acid Deposition Monitoring Region 1 has operated an acid deposition monitor at Lost Trail Pass as part of the National Atmospheric Deposition Program (NADP) since 1990. This site is one of the highest elevation sites in the western United States, and one of the most challenging in terms of accessibility, with snow on the ground approximately eight months out of each year.

In addition, the Region analyzes data representative of regional Wilderness Areas from several other NADP monitors operated by other partners in Montana and Idaho.

Snowpack Monitoring The Region 1 Air Program partners with the U.S. Geological Survey (USGS) to collect bulk snow samples from several locations in the Northern Rockies. Currently in its 19th year, the snowpack monitoring provides a long term record of snowpack depth and chemical composition of snow deposition. Currently, USGS is working on expanding the monitoring to include dust analyses to assess the potential impacts of climate change.

Lichen Monitoring The Region 1 Air Program partners with Dr. Larry St. Clair of Brigham Young University to sample lichens at eight regional Wilderness Areas on a five-year rotation. As bioindicators of air quality, lichens are analyzed to assess the long-term impacts of air pollution. The most recent rotation added nitrogen analyses, which helps assess the long term effects of deposition.

Visibility Monitoring The Region 1 Air Program operates four monitors as part of the Interagency Monitoring for Protected Visual Environments (IMPROVE) network. When combined with IMPROVE monitors operated by our partners in Idaho, Montana, and Wyoming, each Wilderness Area in Region 1 has representative monitoring for visibility impairment.

The Region 1 Air Program also operates three near real time visibility cameras as part of the Forest Service Visibility Camera Network.

Data Assessment The Region 1 Air Program recently released a General Technical Report (RMRS-GTR-230WWW) entitled "U.S. Forest Service Region 1 Lake Chemistry, NADP, and IMPROVE Air Quality Data Analysis." This report[8] details advanced statistical analyses used to detect trends in lake monitoring, acid deposition, and visibility monitoring.

Regional Support

Regional air quality monitoring efforts would not be possible without the support of sample collectors and operators at the Forest and District Level. The Region 1 Air Program acknowledges their hard efforts and dedication:

Lake Sampling	Josh Boyd	Kootenai NF
	Bill Goslin	Bitterroot NF
	Mark Story Jill Grenon	Gallatin NF
	Suzanne Cable Paul Marone	Nez Perce NF
NADP Monitoring	Sula Ranger District Ruth Wooding, District Ranger	Bitterroot NF
IMPROVE Monitoring Visibility Camera Monitoring	Tanya Neidhardt Jon Rupp Melissa Wegner Justin Abbey John Walters	Bitterroot NF
	Jim Blackburn	Lolo NF
	Dave Madden Gabe Witham	Helena NF
	Bruce Haflich	Kootenai NF

[8] http://www.fs.fed.us/rm/publications/titles/rmrs_gtr.html

Regions 2 and 4 Success Stories

Development of a Data Warehouse/Modeling Center:

Area covered by data warehouse.

A Strategy in Response to Oil and Gas Development

State and federal agencies have collaborated and reached a consensus on a proposal to create and operate a shared Data Warehouse with modeling capabilities for air quality management in the intermountain west region.

Agencies involved in this effort have consolidated resources and designed an air quality monitoring network and data warehouse and a timeline for implementation.

Agency Support:

States of Colorado, Utah, and Wyoming
Bureau of Land Management, U.S. Forest Service, and National Park Service
The Environmental Protection Agency

Regional Support:

The U.S. Forest Service has committed a total of $780,000 in this effort. Region 4 committed $600,000 in $200,000 increments over three years. Region 2 committed $180,000 in the form of ozone monitoring equipment.

Some of the monitoring equipment purchased.

Region 3 Success Stories

A Year in Transition

The hiring of two new air specialists, Susanna Ehlers in April 2009 and Josh Hall in March 2010, created an opportunity to build an air program responsive to current needs in the Region. Introducing and training for the new employees and understanding the specific needs of the Southwest have been a major theme of the past year. In addition to maintaining smoke management as a top priority, the Air Program focused on increased participation in work groups that would build collaboration across agencies and regions.

Monitoring

The Air Program created a new Regional monitoring database containing the location, operator, and type of instrumentation for Arizona and New Mexico**.**

In addition, the Region built a partnership with the New Mexico Environment Department (NMED) to jointly operate and fund an ozone monitoring station on the Coyote District of the Santa Fe National Forest.

Air Quality Assessments

The Air Program has responded to a need for a consistent approach to quantitative air quality assessments. Utilizing travel management planning as an opportunity to provide a useful template, the Air Program developed an outline of air quality analysis components. The Regional Air Program has improved NEPA assessments for smoke impacts by utilizing CONSUME, a smoke emissions model, to calculate PM, CO, CO_2, and CH_4 emissions from prescribed fire. CONSUME outputs are compared with emissions inventories to validate the model results. Emissions coefficients are input to state- and transition models to provide smoke and carbon accounting projections to management scenarios at landscape levels.

Building Partnerships

The cornerstone of building the R3 Air Program has been developing solid relationships with industry, state and local governments, and other land management agencies involved in air quality issues. The R3 Air Program participates in the Western Regional Air Partnership, the Four Corners Air Quality Group, the New Mexico and Arizona Interagency Coordinating Groups, and the Oil and Gas FARM team. The Fossil Creek Comprehensive River Management Plan enabled Air Program staff to work with resource specialists in Arizona to bring awareness to air quality issues, as well as ensure fugitive dust concerns were considered in the management plan.

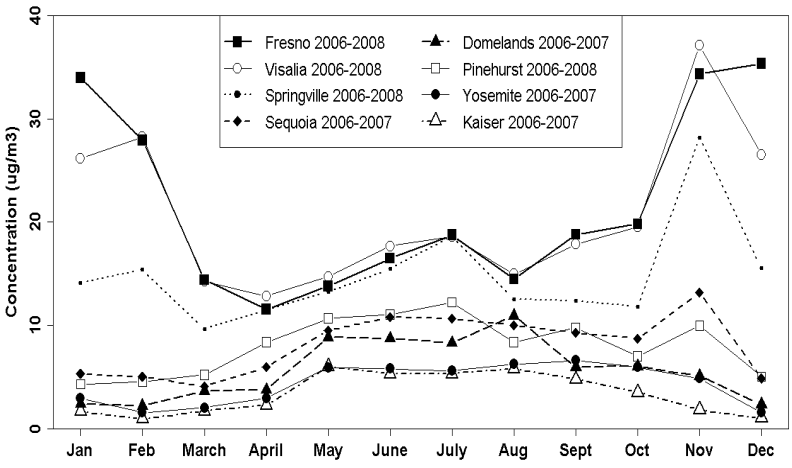
In addition, the Ten Year Wilderness Stewardship Challenge project initiated much needed work on the air quality element in wilderness planning.

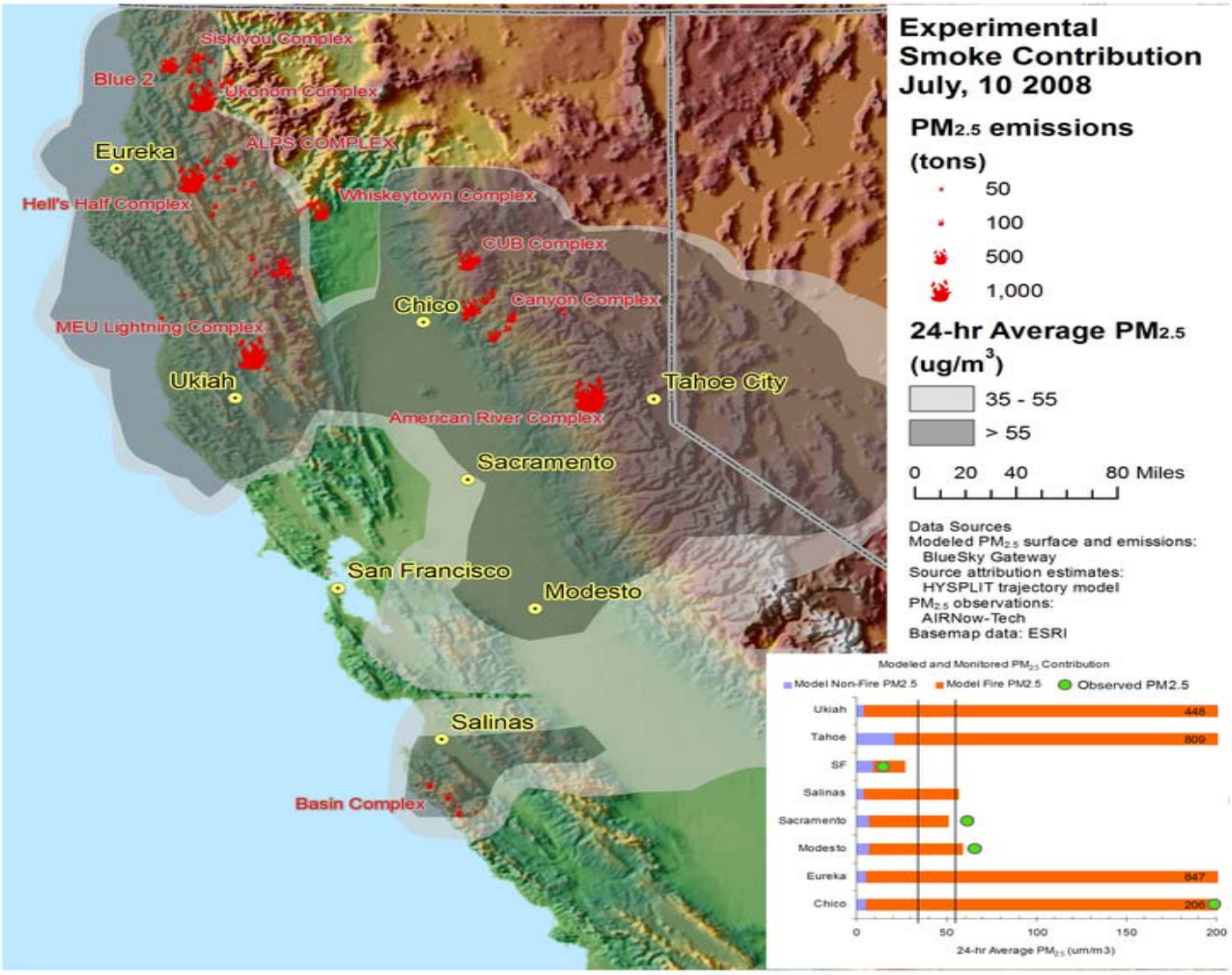
Region 5 Success Stories

Smoke Monitoring Program

The R5 Air Program, in collaboration with the Forests of the Southern Sierra, developed an intensive smoke and air monitoring project. The project consists of fixed, portable, and passive sampling devices that over the last 5 years is revealing more information about when and where smoke is and is not impacting local communities. The data is providing confidence among Forest staff and air regulatory agencies in scheduling burn projects in more marginal smoke dispersion conditions.

The data is indicating that the larger valley communities of Fresno and Visalia experience high particulate matter levels in the winter months. These are the communities that drive the non-attainment designation of the San Joaquin Valley Air Basin. The data supports the fact that applying prescribed or managed fire during spring and summer months will not likely contribute to the non-attainment issue.





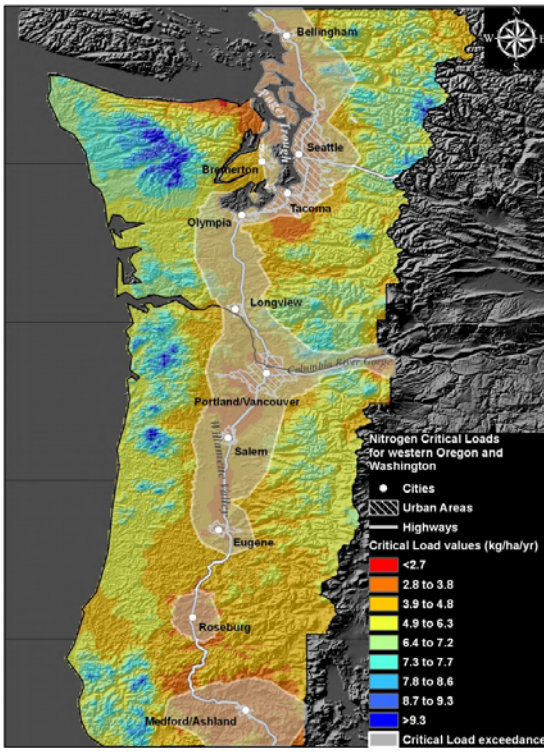
Primary sources of smoke at selected locations (estimated percentage)

Fire or Complex	Chico	Eureka	Modesto	Sacramento	Salinas	SF	Tahoe	Ukiah
Hell's Half Complex		2	52	18		5		26
Basin Complex					97			
Ukonom Complex		18				57		17
Canyon Complex	50	1		7			30	
CUB Complex	47	1		26		6	7	
MEU Lightning Complex			15	32				32
American River Complex							58	
Blue 2		37				9		5
Badger Mountain, WA		26				10		
Alps Complex		1	15	5		6		9
Siskiyou Complex		12				3		1
Whiskeytown Complex	3		7	3			1	2

In 2008, the Air Program's smoke monitoring (particulate matter) instrumentation was partnered with equipment supplied by the AirFire team at PNW, the California Air Resources Board and analysis procured from Sonoma Technology. The analytical products included daily smoke forecasts and estimates of smoke contribution as shown in this example from July 10th. This information assisted the air regulators and health officials in developing more reliable health hazard alerts.

Region 6 Success Stories

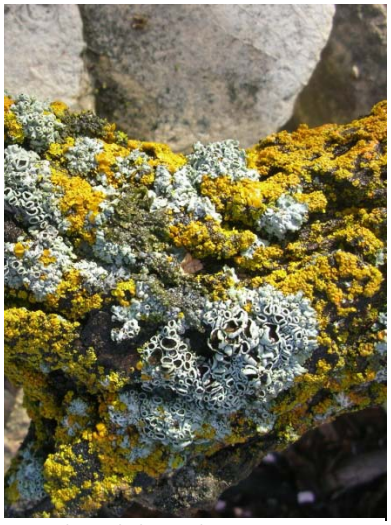
The primary air pollutant affecting forest vegetation in the Pacific Northwest Region is nitrogen deposition. This pollutant is emitted to the air as NOx from the combustion of fossil fuels and as ammonia volatilized from agricultural fertilizers and animal manures. Nitrogen causes eutrophication of ecosystems, characterized by species composition shifts favoring weedy, early seral, and disturbance species and favoring grasses over shrubs. Nitrogen also affects soil chemistry and saturated soils leak nitrogen to streams and waterways and lakes, changing composition of organisms and promoting algal blooms which can change pH and cause anoxia dangerous to fish.



Map of nitrogen critical loads protective of the regions' most air pollution sensitive vegetation, e.g. epiphytic lichens.

Endemic epiphytes of Pacific Northwest forests evolved in very clean air environments and are adapted to low levels of pollution and nutrient availability. They play important ecological roles in the forest as forage and nesting materials for birds, small mammals, and ungulates.

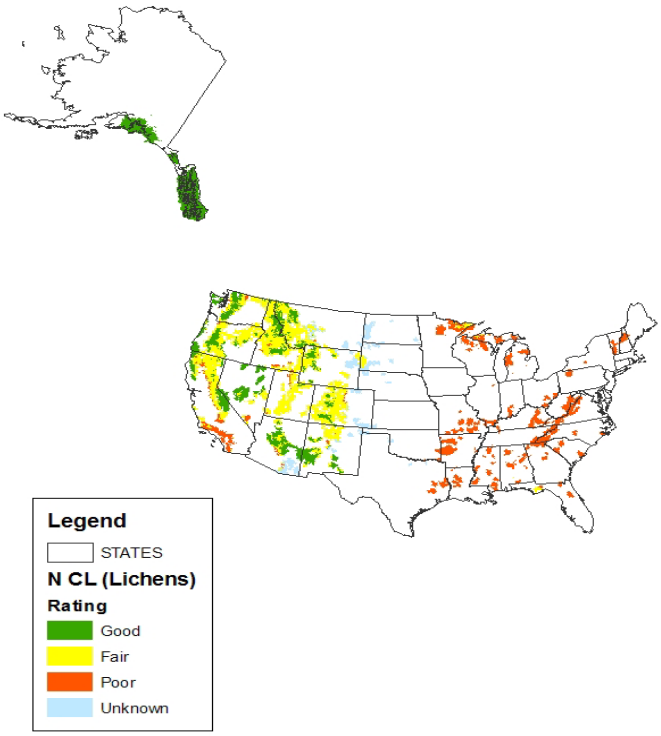
Epiphytes are the vegetation that grows in canopies and include lichens, mosses, liverworts, and ferns. These species are especially sensitive to air pollution because all of their water and nutrients come from the canopy, primarily from precipitation and dry deposition of particulates. By monitoring the species that are present, it is possible to evaluate trends in the status of air quality. Lichens are especially sensitive to nutrient nitrogen, acidic deposition, and sulfur dioxide. The R6 Air Program maintains a net work of monitoring sites that, together with the state and private lands monitored by the FIA-FHM program, covers all forested lands in Oregon and Washington (About 1500 survey sites).



Nitrophytic lichens thrive in nutrient rich environments and gradually replace the endemic species as nitrogen availability from atmospheric sources increases, i.e. they are characteristic of eutrophied environments. These species have little ecological value.

In 2010, we published the first critical loads for nutrient nitrogen deposition in western Oregon and Washington. These are marine forests of the west coast that extend through southeastern Alaska and northern

California. Critical loads tell us how much nitrogen deposition is safe for any ecosystem component. Above the critical load, adverse effects can be expected. By protecting the most sensitive components, ecosystem-wide protection is more likely.



Status of watersheds within the US National Forest System with regard to nutrient nitrogen deposition. Most of the eastern US and southern California have pollution levels that exceed the critical load (red), whereas the rest of the west generally is clean (green) or experiences nitrogen deposition levels that are within 1 kg/ha/yr of the critical load (yellow). Critical loads varied between 3 and 9 kg/ha/yr across the US, varying with precipitation, temperature, and forest type.

Models to estimate lichen critical loads in the PNW were recently applied to other national forests of Mediterranean California and the western Sierras and found to replicate critical loads published for these areas (Geiser et al. 2010, Fenn et al. 2010). It has since been used to predict lichen critical loads in other forested ecosystems of the US (Pardo et al., Eco. Applications in Review) and to map watersheds within the National Forest System that exceed critical loads for this most sensitive vegetation (National Watershed Assessment).

Regions 8 and 9 Success Stories

Three ARM success stories for the Eastern and Southern regions reported here are products of collaborative efforts demonstrated by Air staff of one or both regions. It is also appropriate to acknowledge that these success stories were not forged in a single year, but were collective products of many years of research and collaboration between multiple staff members of FS NFS and Researchers both inside and outside the Agency, demonstrating the "All Hands, All Lands" approach championed by the U.S. Department of Agriculture.

Development of critical loads for sulfur deposition in the Southern Appalachians:

Cold Mountain in the Shining Rock Wilderness in Pisgah National Forest, NC

Critical Loads define the amount of pollution an ecosystem can tolerate, and, when combined with current deposition information, show where harmful effects are occurring. This type of information improves communication between resource managers and air regulators and can lead to pollution control strategies that will help protect or restore ecosystems. The ARM specialists in Regions 8 and 9 have worked tirelessly with FS Research and others over many years to establish critical loads for sulfur deposition in the Appalachian Plateau and Southern Appalachians. Aquatic critical loads have now been calculated for many watersheds on National Forests in North Carolina, Tennessee, Virginia, and West Virginia and this information has been used in recent watershed assessment and restoration efforts. Whether monitoring soil and water chemistry, developing essential, nationally recognized concepts, or co-authoring peer reviewed research papers, the ARM specialists are recognized leaders in efforts to legitimize the use of critical loads in forest management. U.S. EPA and the National Atmospheric Deposition Program have recognized their contributions.

Dead Spruce, Presidential Range Wilderness Area, White Mountain NF

Integration of air related metrics into the Watershed Condition Class (WCC) Assessment:

When the importance of quantifying the Forest Service's efforts to evaluate and improve watershed condition became imperative three years ago, the region's Program Manager, Chuck Sams, saw the need to include air related metrics in the Watershed Condition Framework to watershed viability, by the inclusion of air related metrics in the Assessment Framework. What followed was the collaboration of FS Research with multiple ARM staff and leadership from R8 ARM staff, to generate web based, GIS friendly tools, allowing forests to easily utilize ARM metrics for all FS sub-watersheds, nationally.

White Mountain NF in winter, looking into the Great Gulf Class I Wilderness Area

Collaboration between the Forest Service, the U.S. Department of Justice, and the U.S. Environmental Protection Agency, resulting in air pollutant mitigation projects on FS lands, funded by proceeds from Prevention of Significant Deterioration enforcement actions:

On March 18, 2010, the U.S. District Court for the Southern District of Indiana approved a partial consent decree in the UNITED STATES OF AMERICA, *et al.* v. CINERGY CORPORATION, *et al*. (Civil Action No. 1:99-cv-01693-LJM-JMS), an important Prevention of Significant Deterioration (PSD) litigation stemming from the Cinergy Energy Gallagher Plant's alleged violation of the Clean Air Act. This result was an award of $250,000 to carry out work for the rehabilitation of Forest Service lands, focusing on the Hoosier National Forest, Pisgah National Forest, Nantahala National Forest, Cherokee National Forest, Jefferson National Forest, and/or Daniel Boone National Forest. At the date of this writing, over $169,000 has been awarded to the Cherokee, the Daniel Boone, the Pisgah, and the GW/Jeff for a variety of projects addressing the impacts of acidic deposition to forest resources. This was the culmination of many years of legwork by Chuck Sams and Bill Jackson to have USEPA and the Department of Justice recognize the Forest Service

Duke Energy's Gallagher Station

as a legitimate recipient of awards associated with prosecutions involving violation of the PSD section of the Clean Air Act. Since then, another PSD case involving Hoosier Energy and the same court resulted in a $200,000 award for similar work to be done on the Hoosier National Forest.

Stream Crossing, Hoosier National Forest

Region 10 Success stories

Increased cruise-ship tourism in Southeast Alaska has been accompanied by increasing concerns about air pollution (*Furbish et al. 2000*). Combustion of low-grade marine fuels releases nitrogen and sulfur oxides, poly-cyclic aromatic hydrocarbons, and metals (*Graw et al., this issue*). In Skagway, frequent summer-time inversions prevent dispersal of emissions from in-port operation of diesel and bunker fuel generators, resulting in noticeable haze and odors in much of the park. Ships in transit in the narrow fjords of Glacier Bay National Park and Preserve and Tracy Arm-Fords Terror Wilderness of the Tongass National Forest also produce visible plumes. Recently, managers of the Tongass, Glacier Bay, Klondike Gold Rush National Historical Park (NHP), Skagway, and Sitka NHP combined resources to establish monitoring plots designed to assess status of and trends in air quality and detect ecological effects on sensitive epiphytic vegetation due to air pollution. Cruise ship emissions are dominant pollution sources at all sites.

Emissions from cruise ships docked in Skagway harbor cause extensive haze and odors in Klondike Gold Rush National Historical Park and the Municipality of Skagway. Monitoring is designed to measure levels and ecological effects of pollutants associated with marine fuel combustion.

Monitoring was conducted for air pollution concentration, deposition, precipitation chemistry, and vegetation response. Ogawa passive samplers were used to measure ambient concentrations of nitrogen oxide, ammonia, and sulfur dioxide gases. Canopy throughfall samplers were used to measure precipitation chemistry of nitrate, ammonium, and sulfate ions. Total deposition was characterized from elemental analysis of epiphytic lichens, which was then compared to clean site ranges for nitrogen, sulfur, and metals. Community surveys of epiphytic lichens were conducted to assess status of sensitive species. Elemental analysis data were compared to Tongass NF baselines (*Dillman et al. 2007*); managers at this forest have maintained a network of about 120 permanent air quality biomonitoring plots since 1989 (*Geiser et al. 1994*).

Passive samplers were used to measure ambient concentrations of sulfur dioxide, nitrogen oxides, ammonia, and nitric acid—gaseous pollutants that can be harmful to plants, wildlife and people.

A multi-agency, regional monitoring program is in place to measure regional and local air pollutants accumulated by vegetation and in deposition. Early results suggest that nitrogen and sulfur oxides, and deposition of sulfur, lead, zinc, and vanadium are elevated in Klondike Gold Rush National Historical Park and the adjacent Skagway municipality. Nitrogen and sulfur deposition were elevated at Sitka NHP. Ten-year re-measurements from Klondike and Skagway provide evidence of increasing nitrogen and decreasing lead and nickel deposition, consistent with increased cruise ship port time and the discontinuation of uncontained mining ore transfers in Skagway harbor. Strongest pollution zones correspond with highest human population densities.

Results

Pollutant levels accumulated by lichens can be compared to expected clean-site ranges and indicate pollution-impacted areas. Elevated levels of sulfur and nitrogen are usually associated with loss of sensitive species. (A) Collecting lichens along Dewey Lakes trail above the Skagway terminal; (B) Platismatia glauca; (C) Hypogymnia enteromorpha.

Work is still on-going but some initial results can be reported.

- One to five cruise ships dock in Skagway harbor each day from May to September. Visible haze accumulates in the morning on most of these days beginning at the Skagway terminal and spreading up and down Skagway River valley. The odor of diesel fumes can be detected by residents and also by visitors exploring the historic buildings in town and hiking on the trail system.
- Nitrogen oxides were elevated and five to ten times higher in Klondike at Icy Junction and in Skagway along the lower Dewey Lakes Trail compared to Glacier Bay and Sitka NHP. Sulfur dioxide was elevated in Skagway along Dewey Lakes trail and at Sturgill's Landing but not at other sites.
- The increase in ship traffic over the past ten years is correlated with small increases in nitrogen accumulated in epiphytic vegetation (lichens) at sites close to Skagway harbor.
- Sulfur levels associated with adverse effects to sensitive plants were primarily observed in Klondike lichens within 1.2 miles (2 km) of Skagway and at Sitka NHP.
- Lead, nickel, cadmium, and zinc levels in lichens were within background ranges at most sites, but still strongly elevated at Klondike sites closest to the Skagway terminal, a legacy from historic use of the harbor to transfer lead and zinc ore from open rail cars and trucks to barges.
- Vanadium, a product of diesel combustion, was very high at sites closest to the Skagway terminal, especially on the forested fjord walls along Dewey Lakes trail above the harbor.

Management Implications

- Reducing cruise ship emissions would have beneficial effects on visitor experiences of visibility and odor. In Skagway, it would also reduce potential human health effects from combustion-related air pollutants such as fine particulates, hazardous air pollutants, and metals.
- Because pollutant concentrations fall off rapidly with distance from sources, the worst impacts can be expected in locations close to docking areas or where topographic and meteorological conditions frequently combine to trap emissions close to the ground.
- Nitrogen and sulfur containing pollutants are quickly processed compared to many metals, which have a much longer residence time (decades vs. years) in soils and vegetation.
- Continued monitoring of established sites can be used to verify effectiveness of Air Resource Management policies. It could be important to measure particulate matter levels because nitrogen oxides, sulfur dioxide and ammonia form sulfate and nitrate aerosols which are hazardous to inhale and are precursors of acidic deposition.